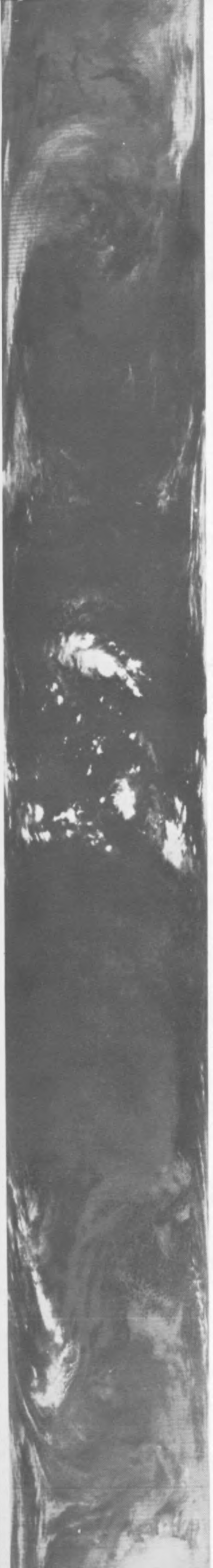
GODDARD NEWS

GODDARD SPACE FLIGHT CENTER / GREENBELT, MARYLAND

THE NATIONAL AERONAUTICS AND SPACE ADMINISTRATION MAY 30, 1966



TYPHOON IRMA is photographed at near midnight some 400 miles southeast of Manila in the Philippine Islands.

LESS THAN 6 HOURS AFTER LAUNCH, Nimbus II took this remarkable nighttime photo showing a strip 1800 miles wide and 10,000 miles long extending from the ice cap surrounding the South Pole (bottom of photo) to the Kamchatka Peninsula (top).

Space-Age Research Tools Aid Aurora Investigators

Sydney Chapman Addresses Goddard Scientific Colloquium

Professor Sydney Chapman, renowned geophysicist and father figure to most researchers in the field today, impressed a Goddard Scientific Colloquium on May 13 with the awareness that man has recently emerged from the Dark Ages in his knowledge of such near-space phenomena as auroras, a direct result of the vast research potential of sounding rockets and satellites.

According to Jaylee Burley, Goddard astronomer and colloquium coordinator, these quiet winter spectacles "are rapidly falling into the category of scientifically explicable phenomena." Within the last few decades, she says, the inventions and inventiveness of scientists have brought us from a state of superstition and ignorance to the midst of a learning process of tumultuous speed.

Dr. Chapman, who holds positions at the High Altitude Observatory in Boulder, Colorado, and the Geophysical Institute in College, Alaska, has probably done more for the field of geomagnetism than any other individual. As Dr. Masahisa Sugiura of Goddard's Space Sciences Division said in introducing Dr. Chapman, "One can almost feel his presence in the sciences of geomagnetism and aeronomy. If an organization in these fields hasn't had him as its president at some time, there is probably something wrong with the organization."

Still mentally and physically vigorous at the age of 78, Dr. Chapman is credited with building the first realistic model of the ionosphere, the first explanation of magnetic storms, and, with another scientist, the theory of ionized gases. The standard textbook used in geomagnetism studies was written by Chapman and Bartels.

In describing the effects of geomagnetic structure and disturbances on auroras, Dr. Chapman drew upon the background of a life's research and study, speaking of these atmospheric wonders with a familiarity and naturalness that belied their remoteness and intangibility.

The region of auroral occurrences is slightly lopsided, dipping about midway into Canada but just touching the northernmost tip of Russia. It passes near the northern tip of Norway, directly over Iceland, near the southern tip of Greenland, through Fort Churchill (Manitoba) and Fairbanks, Alaska. During periods of high solar activity, this line may move as far south as Miami or Mexico City. The record observation took place in the Sudan at about 6 degrees north of the equator when a legion of Roman soldiers marched toward a brilliant aurora all night to assist in putting out what they thought was a disastrous fire in a nearby town.

Auroras generally occur at an altitude of about 100 kilometers, though they may be as high as 800. All-sky coverage during the International Geophysical Year (90 cameras in the Southern Hemisphere, 30 in the north) gave the first evidence that auroras can extend for great distances; one was measured along a path of 5000 kilometers across North America all the way to Siberia. During periods of quiet in the lower magnetosphere, auroras are about three kilometers thick. During more violent periods, electric current increases and the aurora breaks up, thickens, and contracts to a width of about 300 yards, signifying a fine focusing of the energy source causing the glow. Though it is not known yet if an auroral sheet can extend all the way around the earth, Dr. Chap-

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***AURORAS MAY ASSUME A VARIETY OF CONFIGURATIONS**, suggesting the complexity of causes involved.*

AURORA INVESTIGATORS,

from page 1

man predicts that "it will be possible to photograph from a polar circling satellite an aurora extending entirely around the pole."

Auroras are generally considered to be caused by high-energy electrons which enter the earth's atmosphere, collide with air molecules, and release energy. Much of this energy is given off in the form of visible light. Protons were first thought to cause auroras, but are now known to play a relatively small part in producing energy in auroral regions.

Auroras are composed of two basic colors: violet, which is invisible, and pale green, which usually appears as white. When voltage is intense, the emission of oxygen atoms creates vivid red displays such as the one that reputedly drew the Roman soldiers to such effort.

Speaking with slides of charts and diagrams, Dr. Chapman outlined the history of what we know about the sources of auroras. A Norwegian geophysicist named Carl Störmer hypothesized in 1904 that streams of charged particles from the sun influence the earth's environment and that the earth's magnetic field can confine electrons and protons. Astronomers, noting a tendency for solar activity to conform to a 27-day cycle, began to associate sunspot activity with geomagnetic disturbances, especially auroras. E. N. Parker of the United States and others arrived at the conclusion that a solar wind, as this stream of charged particles and other material is called, flows constantly but causes abnormal disturbances on the earth only at times of maximum activity.

The term "magnetic storm" was introduced by Humboldt in 1808, but the idea that solar particles were responsible for magnetic storms had to be defended as late as 1950. Since then, balloons, sounding rockets, and satellites have monitored correlations which make the evidence for this hypothesis very strong. In 1950, protons were observed descending along auroral rays at several thousand feet per second, showing that solar particles were somehow involved.

D. F. Martyn developed a mathematical model of the solar wind's effect on the earth's magnetosphere, showing a pocket created by the earth with the plasma stream flowing around and past it. Dr. Gilbert Mead of Goddard's Theoretical Studies Laboratory has further refined the model on the basis of rocket and satellite data. The "leading edge" of the magnetosphere is badly distorted by the pressure of the solar wind on the resisting force of the earth's dipole field. Most particles are deflected around the earth, like water flowing around a log, but there is evidence that some enter the magnetosphere, either in regions of weak magnetic field or in regions where the boundary is unstable. These particles usually bear a charge of less than a hundred volts.

The side of the magnetosphere away from the sun is extended and relatively calm, like the eddy behind the log. A large magnetically neutral region exists here, beginning several tens of thousands of miles from the Earth and extending an unknown distance. Called the neutral sheet, it contains high-energy particles which may or may not return to play some part in the interactions of the earth's magnetic system.

Dr. Ted Speiser of Goddard's Laboratory for Theoretical Studies has built a mathematical model based on the proposal of English scientist J. W. Dungey that neutral points in the magnetosphere tend to accelerate particles. Dr. Speiser holds that both the neutral point on the sunlit side of the Earth and another in the neutral sheet region provide enough energy to hurl particles into the Earth's atmosphere at speeds sufficient to cause auroras. Others have hypothesized that distortions of the outer regions of the earth's magnetic field might cause sufficient acceleration, or that oscillations of the geomagnetic field, possibly induced by hydromagnetic waves in the solar wind, achieve a "betatron effect" similar to that in a laboratory device in which electrons are brought to high velocities by an oscillating magnetic field.

As yet, there is no experimental evidence that neutral points can do more than admit particles into the earth's magnetosphere, and one of the most fundamental problems in auroral research remains the source of energy. Dr. David Evans of Goddard's Space Science Laboratory this year has launched three Apache rockets from Fort Churchill, Canada, and has found that most of the particles producing the aurora sampled are between one and eight kilovolts. Other samples have revealed predominant energies of 40 or 50 kilovolts. How do low-energy solar particles (100 volts or less) become excited to such levels? And does the wide range of energy levels and physical characteristics of auroras indicate more than one source of excitation?

Many solar particles are trapped in regions near the earth known as the Van Allen Radiation Belts where they bounce back and forth from points in the Northern Hemisphere to conjugate points in the Southern Hemisphere. They follow a spiral course about a magnetic line of force. As a particle approaches the earth, where the magnetic field is more intense, spiralling becomes tighter and forward velocity decreases. The particle reaches what is known as a mirror point where spiral motion reaches a maximum, forward velocity is reversed, and it retraces its journey to the other hemisphere. A complete cycle takes seconds or minutes.

As particles bounce back and forth in this region of trapped radiation, they experience what is known as drift, moving steadily around the earth, electrons eastward and protons westward. A full revolution is made in minutes or hours, depending upon how far the individual particle has to travel in its particular orbit. This rotation of the protons and electrons causes a definite electrical current around the equator.

Scientists used to think that auroras were caused by protons and electrons from this Van Allen region rushing into the earth's atmosphere at certain times and releasing energy, some of which was expended as visible light. More recently, however, auroras

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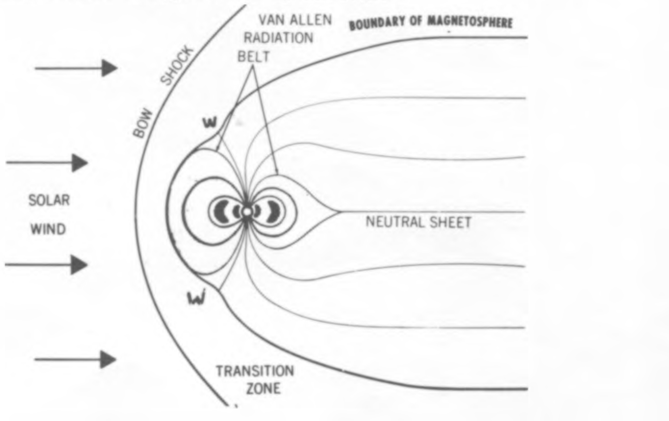
***MOST RECENT DATA PROVIDED BY SOUNDING ROCKETS AND SATELLITES** give the below view of the earth's environment. Weak or unstable points in the magnetosphere boundary, marked "W," may admit charged particles. At right, a thin neutral sheet of uncertain dimensions may provide clues to the energy source of auroras.*



DATA TOPICS

Michael Mahoney, author of this article, is Head of the Project Computations Section of the Information Processing Division. In this capacity he directs the efforts of many of the Division's Data Processing Engineers. He is a graduate engineer with a Bachelor of Science in Electrical Engineering (cum laude) from the University of Miami, and is a member of Pi Mu Epsilon, Phi Eta Sigma, and Tau Beta Pi.

Part I of a two-part series:

The Data Processing Engineer

by Michael Mahoney

A primary function of the Information Processing Division is the processing of satellite telemetry data, starting with the output of the physical sensor on the spacecraft through data sampling, encoding, transmission, ground processing, analysis and display.

On each space mission it is the job of the Data Processing Engineer to pull together the activities of the various disciplines within the division which are required for this task.

He accomplishes this by obtaining assistance in matters concerning flight hardware from the Space Electronics Branch, ground hardware support from the Processor Development Branch, computer software support from Telemetry Computation Branch, and day to day operations support from the Data Processing Branch.

The Data Processing Engineer's activity begins at the inception of each project. He works closely with the project during the conceptual phases of the telemeter design. His goal is to assist those responsible for spacecraft data handling system design to provide for an overall information processing system which is commensurate with the proven equipment and computer processing techniques which are to follow:

Once he has learned the project requirements for data processing, the next step is to formulate a plan for processing the data. This he accomplishes by heading up a team of specialists in telemetry processing equipment, programming, and operations. Together the team formulates a Data Processing Plan, and a program for implementation of that plan.

On occasion special ground equipment must be assembled to meet new or non-standard requirements.

Although we are making great strides in the development of telemetry software, we are still required to develop new digital computer software systems for each new satellite series.

With the advent of new ground equipment such as STARS PHASE II (a unified raw telemetry front end and digital computer complex) new operations procedures must also be developed.

One of the important jobs of each D.P.E. is the development of the Information Processing Division capability to meet new requirements with a minimum of lead time and effort. This is a difficult task since there are many ways of performing each process in the data path from spacecraft sensor through ground processing, to final experimenter analysis.

As an example—some of the encoding techniques now in use include: Frequency Modulation (FM), Pulse Code Modulation (PCM), Pulse Frequency Modulation (PFM), and Pulse Amplitude Modulation (PAM). Many others are possible and are indeed used from time to time. Of course, the encoding technique, transmission, recording techniques and other variables influence the processing steps that follow.

Continued next issue.

Meet Our People

This is another in a series of articles on Goddard personalities

Harry Press

Nimbus II, the nation's largest and most complex weather satellite, was the result of a team effort involving thousands of people working on complicated scientific and technological problems for a period of nearly two years. But behind this vast undertaking is the dynamic force of one man who must pull all of the work together, make sure that all specifications are met, coordinate the satellite's launch procedure, flight operations and post-flight data evaluation. For the past five years, Goddard's Harry Press has been the "dynamic force" behind the Nimbus program.

As Nimbus Project Manager, Mr. Press heads up a 120-man team and is responsible for all aspects of the Nimbus program, including the spacecraft, and the ground stations which receive weather pictures and information on how the satellite is working.

Mr. Press graduated in 1940 with a Bachelor of Arts degree in mathematics from Brooklyn College in New York. He has done graduate work in mathematical statistics and meteorology at Columbia University and New York University respectively.

As a 1st. Lieutenant in the United States Air Force during World War II, he served as an instructor in meteorology, and as a station weather officer. After his Air Force service, Mr. Press accepted a position with the National Advisory Committee for Aeronautics (NACA)—renamed the National Aeronautics and Space Administration in 1958—at the Langley Research Center in Langley Field, Virginia, where he worked until 1958.

While at Langley he worked on airplane and missile structural loads, analytical and flight-test research programs and in flight operations. He transferred from Langley to NASA Headquarters, Washington, D.C., in 1958 where he was Chief of the Structures and Operating Problems Division.

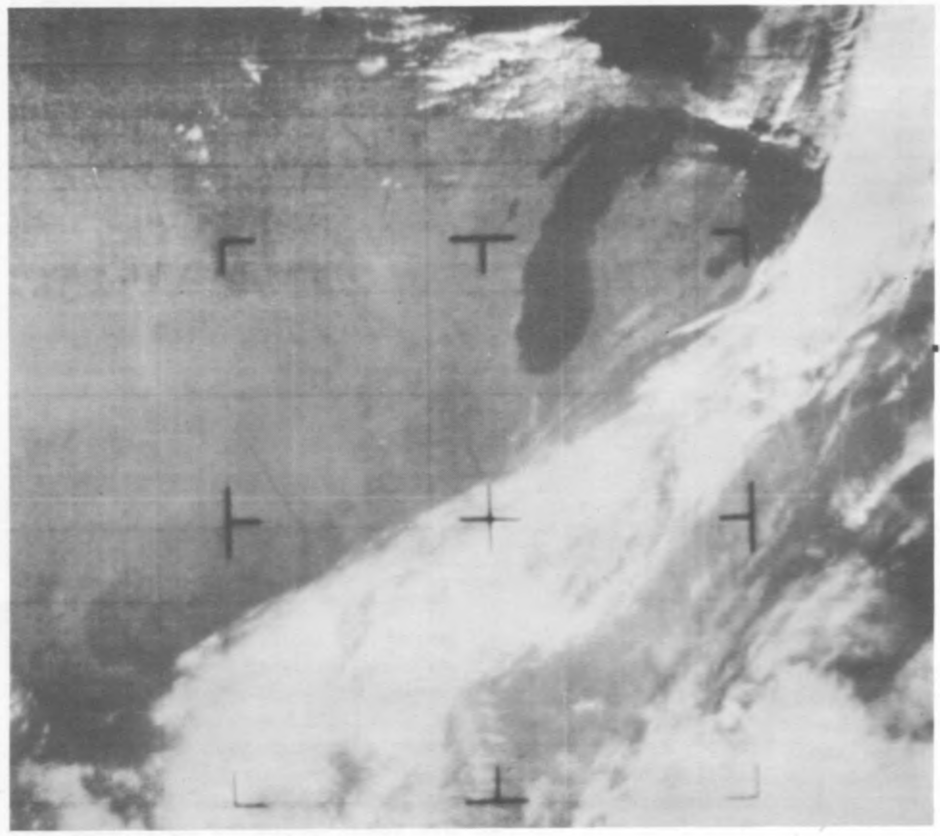
When time permits, Mr. Press enjoys playing tennis and participating in a lively game of bridge. He is a member of the American Meteorology Society, American Statistical Society and the American Institute of Aeronautics and Astronautics.

Mr. Press, a 45-year-old veteran engineer, was born in Kamnetz Podolsk, Russia, and came to the United States when he was two years old with his parents.

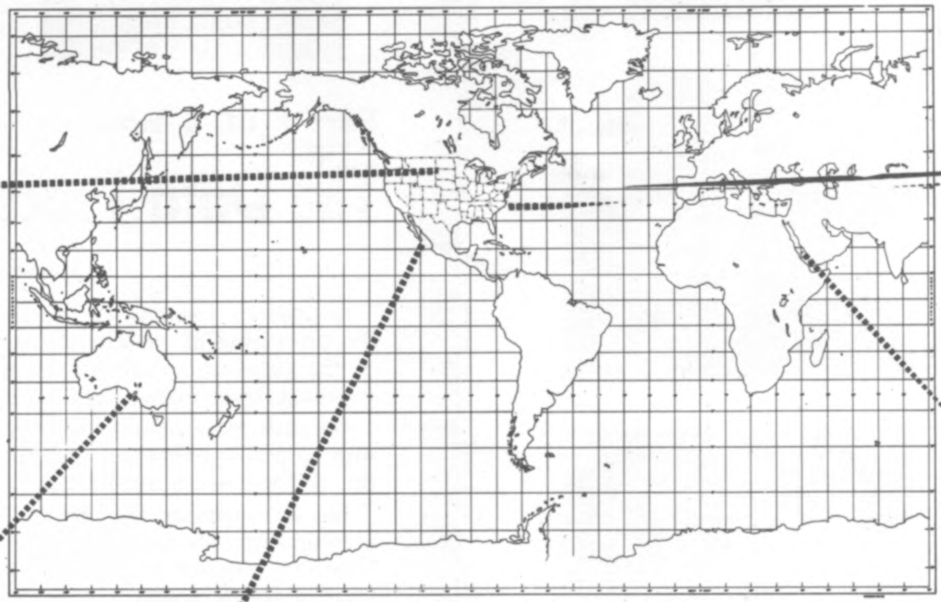
He is married to the former Sylvia Cooper of New York City and they have two children: Dennis (18), and Steve (15). Mr. Press resides with his family at 6712 Brigadoon Drive, Bethesda, Maryland.

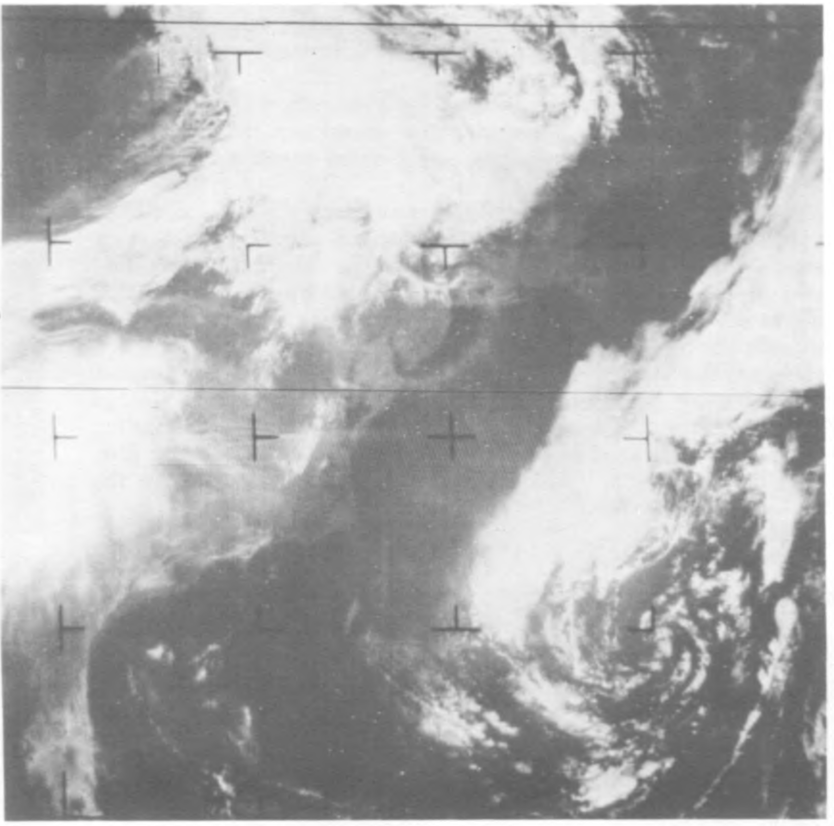
NIMBUS II MAPS THE WORLD

After two weeks in orbit, Nimbus II has provided weather analysis with thousands of photographs. Here is a sampling of the world-wide pictures which are now being received and studied.

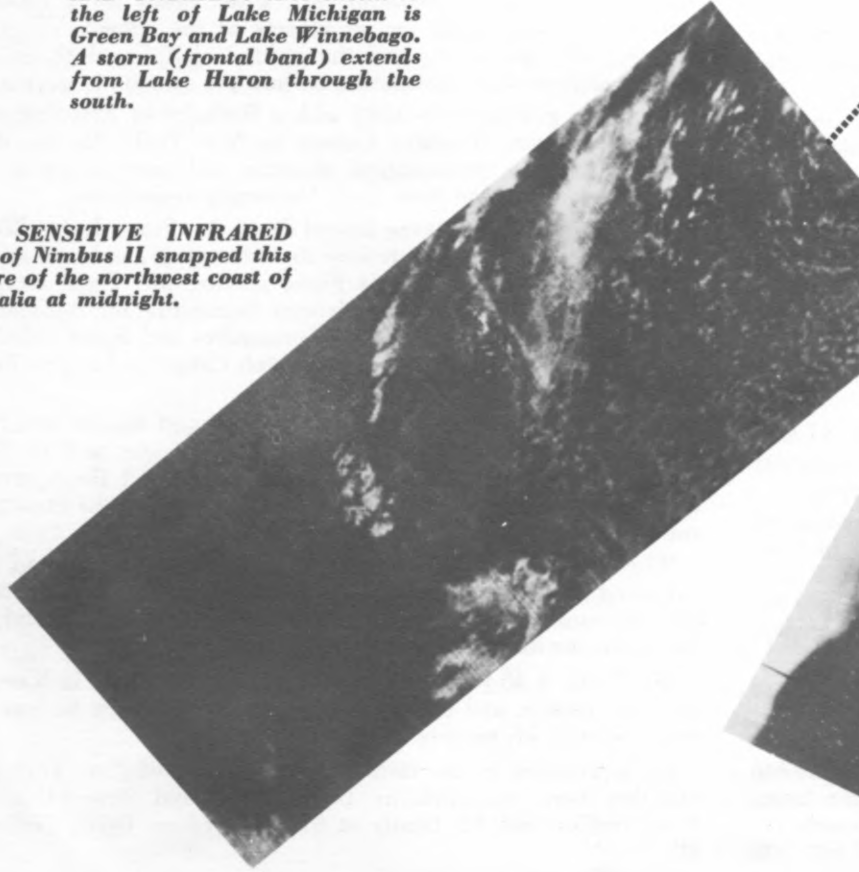


LAKES MICHIGAN, HURON, AND ONTARIO. Also shown to the left of Lake Michigan is Green Bay and Lake Winnebago. A storm (frontal band) extends from Lake Huron through the south.





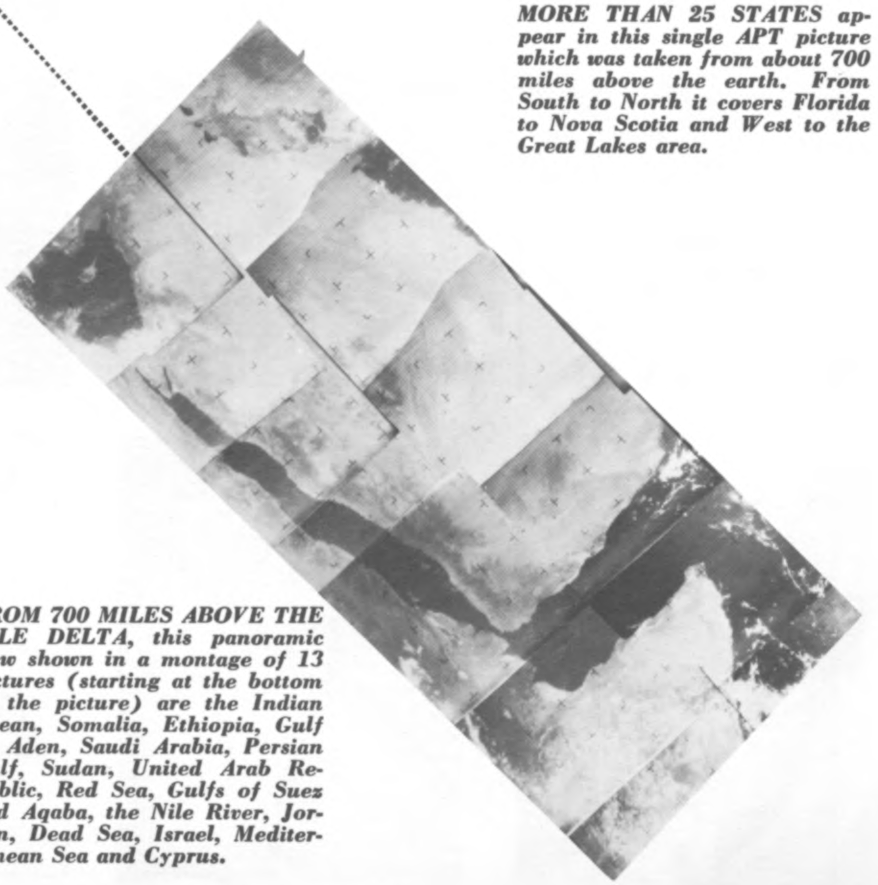
MORE THAN 25 STATES appear in this single APT picture which was taken from about 700 miles above the earth. From South to North it covers Florida to Nova Scotia and West to the Great Lakes area.



THE SENSITIVE INFRARED EYE of Nimbus II snapped this picture of the northwest coast of Australia at midnight.

THIS APT PICTURE SHOWS Baja Peninsula, including Harbor de la Pez at the southern tip, Pacific Ocean, Gulf of California and Mexico.

THE SENSITIVE INFRARED (nighttime) eye of Nimbus II weather satellite photographed these bands of clouds near the equator at midnight May 17 from an altitude of about 700 statute miles. These clouds in the inter-tropical convergence zone circumference the world around the equator and cause violent storms.



FROM 700 MILES ABOVE THE NILE DELTA, this panoramic view shown in a montage of 13 pictures (starting at the bottom of the picture) are the Indian Ocean, Somalia, Ethiopia, Gulf of Aden, Saudi Arabia, Persian Gulf, Sudan, United Arab Republic, Red Sea, Gulfs of Suez and Aqaba, the Nile River, Jordan, Dead Sea, Israel, Mediterranean Sea and Cyprus.

1966 Open House; Enjoyable and Informative

Bigger than a county fair, more fun than a barrel of monkeys, and more popular and informative than a day at the beach, the Goddard Open House served to bring the nation's complex space program before the more than 10,000 people.

The crowd waited in line for such space age attractions as a full scale Mercury capsule which takes a passenger on a "space ride," to sit in a mock-up of the Gemini capsule, and to view the forthcoming Apollo capsule which will serve to transport three men to the moon.

The visitors also watched men of the Fabrication Division build spacecraft components. The fascinated crowd saw demonstrations in glass blowing, optics, plastics, sheet metal forming, machining and welding.

Also on hand for the Open House were many scientific satellites, including an OSO with operational solar cell arrays, six sounding rockets, and displays explaining Goddard's role in the national space program. In addition, at Friendship Airport, nearly 1,000 visitors saw the Goddard instrumented aircraft, which are used to calibrate the STADAN and MFN stations.

During the day, 2,400 people attended 6 fifty-minute space science lecture demonstrations given by John Bannester, George Pope and Ernest Gibson. All of these programs were standing room only affairs. Also, 6,000 people saw a 10 minute film, "Highlights of 1966," which was on continuous showing in the Building 3 Auditorium.

GODDARD NEWS

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"It is difficult to say what is impossible, for the dream of yesterday is the hope of today and the reality of tomorrow."
—Dr. Robert H. Goddard

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Photography by Goddard's Photographic Branch

Experiment Records Signals From Outer Space

A radio astronomy experiment was sent high over the Atlantic Ocean off Wallops Island by Goddard scientists and technicians on May 20.

The purpose of the experiment was to measure the average intensity of radio signals, or "cosmic radio noise," originating outside the solar system—in the Milky Way and from other celestial sources.

Joseph K. Alexander, project director, says, "We are delighted with the flight. A preliminary study of the data indicates, in a nutshell, that everything worked well. The antennas held up well and our instruments received strong signals throughout the flight. This is the first time two pair of antennas of this length were deployed from a spinning rocket. Just prior to deployment, the rocket was spinning at 19 revolutions per minute. In the course of being extended the antennas further de-spun the payload to less than 1 rpm. The results of these experiments will be extremely useful for the Radio Astronomy Explorer satellite program set for launch next year."

The results are expected to yield new information useful to scientists studying the problems of the formation of our galaxy, and other physical processes occurring in the Milky Way.

Laden with radio frequency receivers, transmitters, whip antennas, magnetometers, and solar aspect sensors, the 100-pound payload was boosted in a suborbital ballistic trajectory with an apogee of 570 statute miles.

Measurements were made at frequencies which cannot be accurately detected by ground-based receivers. This was accomplished by placing two simple radio telescopes—each consisting of a 120-foot dipole antenna and radio receiver—above the earth's ionosphere.

JOSEPH K. ALEXANDER, project director (seated) and Payload Supervisor Jim Guthrie, review the cosmic radio noise data from the flight.

Each 120-foot antenna was formed by deploying two 60-foot booms in space. The antennas were 2-inch wide metal ribbons which unrolled from the payload and curled into half-inch diameter metal tubes.

The launch vehicle was a four-stage, 50-foot, solid propellant Javelin/Argo D–4, developing 100,000 pounds of thrust at sea level. Liftoff occurred at 3:04 p.m. EDT. The spent fourth-stage motor and payload landed 620 miles downrange in the Atlantic Ocean. No recovery operation was involved.

This was one in a series of experiments leading to the Radio Astronomy Explorer satellites to be developed and launched in the future, under the direction of Goddard's Dr. Robert G. Stone.

AURORA INVESTIGATORS, *from page 2*

have been witnessed at the same time that the fluxes in the Van Allen regions have been increasing. If they were the source of auroral electron energy, their intensity would always decrease simultaneously with auroral displays. Also, sounding rockets have revealed that the energy spectra of the two phenomena differ significantly.

In the hope of mapping both electrical and magnetic fields in the region of auroras, Dr. Wilmot Hess, Chief of Goddard's Laboratory for Theoretical Studies, has planned to send an Aerobee 350 rocket to an altitude of about 400 kilometers next winter to shoot out a beam of electrons of one ampere varying from one to ten kilovolts. He hopes to be able to measure the efficiency of light production for different energy levels during the six to seven minutes that the rocket will be at a suitable altitude and observe the diffusion behavior of the electron beam. Hopefully, a larger accelerator will be flown into orbit on a future Apollo satellite for more extensive study.

The most valuable additions to the geophysicist's knowledge will probably come, predicts Dr. Chapman, as a result of the present opportunities to make simultaneous measurements at different points in the magnetosphere and on the ground. Satellite operations are becoming comprehensive enough that we have already achieved contemporaneous observations. For example, Dr. Donald Williams of the Laboratory for Space Sciences monitored on a polar orbiting Navy satellite a sudden shift of six to eight degrees southward of the boundary of the trapped particle region at the same time that IMP I passed through the tail region of the magnetosphere, recording a strong increase in magnetic field strength during a magnetic storm.

Such observations may be usefully correlated with ground measurements such as those being studied by Dr. Kaichi Maeda, of the Laboratory for Theoretical Studies. Dr. Maeda is investigating a slight but definite pressure wave on the earth caused during magnetic storms which in 1962 was found to be caused by auroras. Several theories have been advanced to account for this pressure wave—one-fiftieth of a millibar, compared with normal air pressure of 1000 mb—but Dr. Maeda sees the most valid relationship between the pressure rise and ionospheric expansion and heating during a magnetic storm.

Auroras are such complicated phenomena that no one explanation is likely to answer all questions. Some scientists object that while working with theoretical models can be helpful in explaining data results, one cannot fairly generalize from models because of auroral variations from quiet bands to wildly complex situations that often do not even seem related.

Dr. James Heppner of the Space Sciences Laboratory says that measurements of electric fields in the vicinity of auroras will far outweigh anything else that can be done. In the past, he says, programs have concentrated largely upon magnetic measurements, while in reality magnetic phenomena are the results of the more basic electrical structure of the magnetosphere. The possibility of making electric field measurements is now known to be possible by observing the difference in potential between instruments mounted on the ends of long arms in space. This difference in potential, since it is the cause of electric current, promises to tell us more about the fundamental problem of how energy is exchanged between magnetosphere and ionosphere—"a problem so complex and fundamental that there is no isolated experiment that will answer it."

Editor's Note:

Alan H. Anderson, the author of this article, is working in the Public Information Office on a university sponsored internship as part of his masters program. Mr. Anderson graduated from Yale, worked with the Smithsonian Institution as a Biologist in Honolulu and later joined the Public Information staff of the National Academy of Sciences.

Goddard Institute Marks Fifth Anniversary With Lecture By Dr. Urey

The Goddard Institute for Space Studies observed its 5th anniversary recently with a special lecture by Nobel Prize winner Harold C. Urey.

Dr. Harold C. Urey

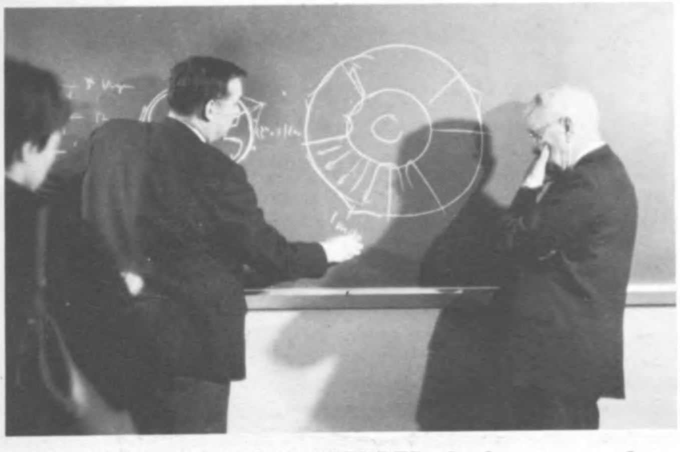
Dr. Urey spoke on the "Origin of the Solar System" at a joint Columbia University-Goddard Institute seminar in the main conference room of the Institute's new quarters. More than 250 persons attended the lecture.

The occasion also marked Dr. Urey's 73rd birthday.

Dr. Urey received the Nobel Prize in Chemistry in 1934 for the discovery of deuterium (heavy hydrogen), while a professor at Columbia. He is now Professor at Large at the University of California at La Jolla.

Dr. Urey was Dr. Robert Jastrow's principal adviser in the formation of NASA's Theoretical Division, which was the Institute's predecessor. He has been a leading source of advice on the Institute's programs in lunar and planetary physics. He is also one of NASA's principal consultants on the lunar program and on questions relating to the origin of life and the origin of the planets.

The Institute had its beginnings in 1961 when Dr. Jastrow came to New York to establish a new NASA research center in the neighborhood of the Columbia campus. A part of the Goddard Space Flight Center, the Institute was organized to do research in planetary physics and astrophysics in cooperation with universities in the New York area. Current areas of research include the origin and evolution of the solar system; star formation, stellar structure and stellar evolution; nucleosynthesis; galactic structure; infrared astronomy; microwave absorption in gaseous atmospheres; the structure of planetary atmospheres and atmospheric circulation; heat balance and cloud cover distribution in the earth's atmosphere, and scattering in planetary atmospheres.



***MANY OF THOSE WHO ATTENDED** the lecture stayed on afterwards to exchange ideas with Dr. Urey.*

The Institute carries out its program in close association with Columbia, Princeton, and New York Universities, as well as Yale, Yeshiva, the State University at Stony Brook and City University of New York. Members of the research staff hold adjunct appointments in departments of physics, astronomy, and geology, and supervise the Ph.D. research of about 30 graduate students. They also offer several space-related courses.

Columbia University, in cooperation with the Institute, conducts four NASA-sponsored summer programs in space science. Ranging from the junior high school level to the postdoctoral, the programs are the Summer Institute in Space Physics, the Summer Institute in Space Science and Engineering, the Summer Faculty Program in Space Physics, and a Summer Program in Space Sciences for 8th and 9th grade students.

***DR. UREY BLOWS OUT THE BIRTHDAY CANDLES** at a reception preceding his lecture, as Dr. Robert Jastrow, center, director, and Dr. Hong-yee Chiu offer encouragement.*

The six-week institute in space physics for college students is devoted to a course of lectures on theoretical geophysics and astrophysics. It is under the direction of Dr. Jastrow. The parallel program in engineering concentrates on daily lectures in areas of the greatest current interest in space flight engineering, covering both theoretical and applied topics. It is under the direction of Professor J. M. Garrelts, Associate Dean of the School of Engineering and Applied Science at Columbia. In the sixth week of the undergraduate programs, a field trip is conducted to national centers of space research, including Goddard Space Flight Center.

The faculty program is for participants who hold doctorates in physics, astronomy or the earth sciences. It includes daily seminars on problems of current interest in planetary physics and astrophysics, under the direction of Drs. A. G. W. Cameron and S. I. Rasool.

The program for 8th and 9th grade students will combine physics, astronomy, the earth sciences and elements of molecular biology in an interdisciplinary treatment of central problems. It is directed by Dr. William Hoffmann.

***MORE THAN 250 PERSONS** filled the main conference room in the new Goddard Institute quarters to hear the Nobel laureate present his special lecture. The occasion also marked Dr. Urey's 73rd birthday.*